Forest Pest Management

Pacific Southwest Region

Lat 39.93761 Lon -121.21986

March 23, 2000
File Code: 3420

To: District Ranger, Feather River RD, Plumas National Forest

Subject: Entomology Input to the Bucks Fire (NE00 - 10)

At the request of Mike Mateyka, District Silviculturist, Feather River Ranger District, I conducted a field evaluation of the Bucks Fire on October 13, 1999. The objective of my visit was to examine various areas within the fire, determine the level of bark beetle activity and make some projections regarding the role bark beetles were likely to play in the fire damaged areas in the near future. I was accompanied in the field by Mike Mateyka.

Background Information

The Bucks Fire, which started as the Big Fire and Bucks Fire on August 22, 1999, burned approximately 34,000 acres (including over 27,000 acres of National Forest land) before it was contained on October 21, 1999. Approximately 36 % of the area burned at high intensity levels.

Vegetation in the overstory and intermediate levels of the stands are dominated by white fir, red fir, sugar pine, ponderosa pine, and incense cedar (in descending order of occurrence). Lower elevation stands also include patches of Douglas fir and black oak. The understory layer is dominated by white fir, dogwood and shrub species, including golden chinkapin, snowberry, snow brush, deer brush, whitethorn, *Ribes* sp. and pinemat manzanita.

Approximately 60% of the area consists of stands that were logged or burned 50 to 90 years ago. Conifers dominate some areas while others have the same species but different compositions, including high amounts of shrubs and hardwoods. The Bucks Fire heavily impacted these stands as the shrub-seedling-sapling layer was almost completely killed and the smaller trees experienced high levels of mortality.

Another 30% of the area consists of stands dominated by mature to large conifers, which had a younger understory of conifers and shrubs. In general, the fire had less of an impact on these

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older stands as the larger trees were better able to withstand higher fire intensities. The remainder of the area consists of conifer plantations that were planted in the past 5 to 20 years. They were well stocked with conifers, hardwoods, and shrubs. These plantations suffered nearly complete mortality. (Information provided by Mike Mateyka).

It is the intent of the Ranger District to leave all trees that have a reasonable chance of surviving their fire-related injuries. Fire injured trees which are still alive will be evaluated for retention or removal based on criteria presented in The Guidelines for Estimating the Survival of Fire-Damaged Trees in California by W. Wagener (Misc. Paper No. 60, Pacific Southwest Forest and Range Experiment Station, 1961) and comments by C.P. Weatherspoon, where he summarizes and discusses the above mentioned guidelines and provides additional suggestions to facilitate the decision making process related to fire damaged trees (Weatherspoon, C.P. 1987. Proceedings of the 9th Annual Vegetation Management Conference, Nov. 3-5, 1987, Redding, California. Pg. 106-110.)

Additional Information Related to Other Fires

Individual tree and complete fire area monitoring for increases in bark beetle activity following wildfires in Northeastern California on National Forest lands have been conducted by Forest Pest Management specialists since 1994. This monitoring incorporates survey techniques which include annual aerial surveys, ground surveys and monitoring of fire-damaged trees in permanent plots. Some of the wildfires that have been monitored for post-fire bark beetle activity include the Cottonwood (1994, 46,800 acres), Crystal (1994, 7,300 acres) and Pendola (1999; 12,000 acres) fires on the Tahoe National Forest, the Cemetery Fire, (1998, 3,930 acres) on the Plumas National Forest, and the Barkley Fire (1994, 44,000 acres), Byers Fire (1996, 1,019 acres), and Dixie Fire (1996, 1,402 acres) on the Lassen National Forest. In addition to these, monitoring for bark beetle-related mortality is also ongoing following several prescribed wildfires on the above mentioned National Forests.

The results of this monitoring have not indicated any increases in bark beetle population levels (as evidenced by increases in tree mortality directly related to bark beetle attacks) to date. Our data shows that additional mortality observed in the few years following the fires has been primarily from fire-related injuries and not from bark beetles or increases in their populations following the fires. We did observe some bark beetle activity in ponderosa pines following the Barkley Fire; however, this fire occurred under much different conditions than the Bucks Fire. The primary difference being the Barkley Fire occurred toward the end of a protracted drought period where elevated levels of conifer mortality relating to drought/bark beetle interactions were being experienced throughout California (Figures 1 & 2). The Bucks Fire and other more recent fires have occurred during normal or above normal moisture regimes. Normal precipitation positively influences tree health and vigor thus decreasing the susceptibility to successful bark beetle attacks and it is presumed that when tree mortality levels are low that bark beetle population levels are lower as well.

Figure 1. Palmer Drought Severity Index for the Sierra Cascade area from 1987 – 1999.

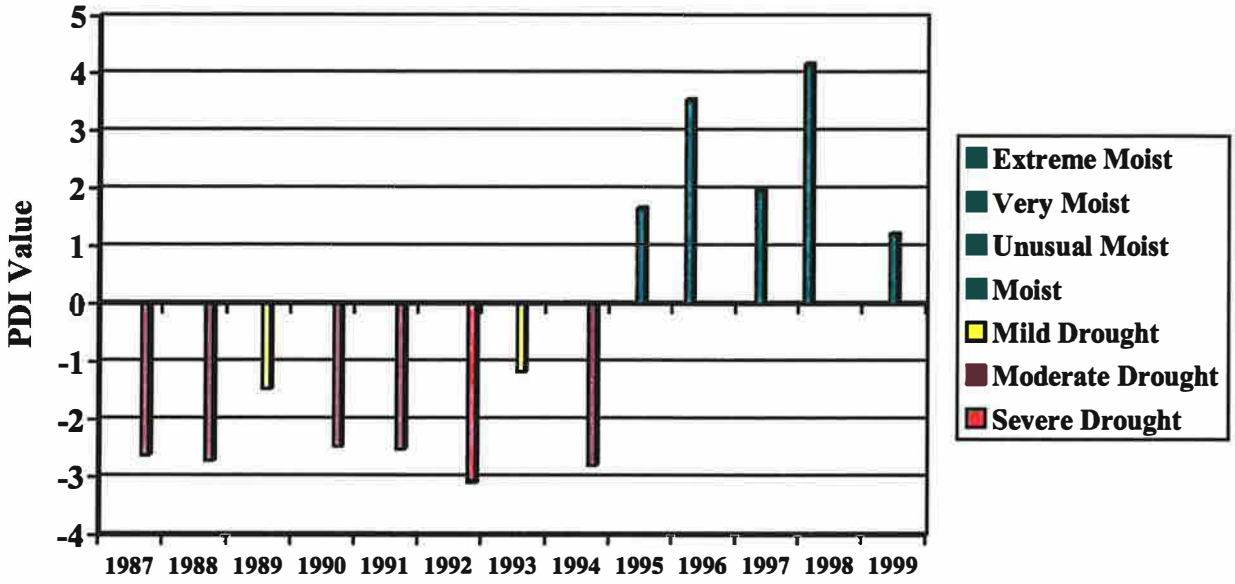
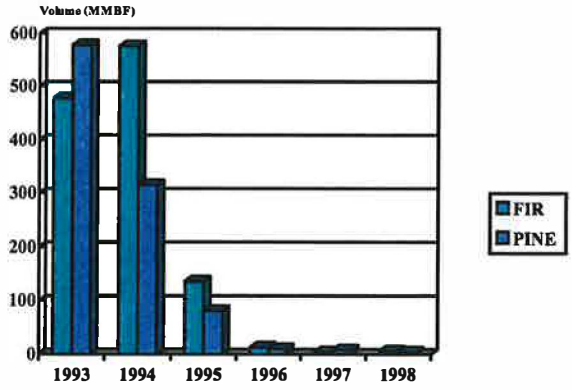


Figure 2. Volume of fir and pine mortality on National Forests in the Southern Cascades and Sierra Nevada mountain ranges between 1993 and 1998 as detected by aerial surveys.



Field Observations

My observations during the field visit indicated very little bark beetle activity that would be associated with an increase in tree mortality. This would be expected due to the fire occuring after what would be considered the main beetle flight season for that area. In addition, it is anticipated that bark beetle populations in the area (as evidenced by very little tree mortality over the past few years) are relatively low due to the previous three seasons of above normal

precipitation, which positively influences the health and vigor of the trees. The beetle activity noted during the field visit was as follows: 1) some of the fire damaged pines have red turpentine beetle pitch tubes near the ground line; 2) a few western pine beetle attacks were present on some pines and 3) there was evidence of secondary beetle activity on many of the fire damaged and killed trees.

Red turpentine beetle, *Dendroctonus valens*

The red turpentine beetle (RTB) normally attacks injured, weakened or dying trees, and freshly cut stumps. The adults are attracted by fresh pine resin. In the Bucks Fire the red turpentine beetles are attracted to the trees with fire-related injuries. A beetle-produced aggregation pheromone is also important in attracting additional beetles into suitable hosts.

Attacks usually occur at the soil line or root crown and are characterized by a large reddish pitch tube at the point of entry. If an attack is successful, the adults excavate an irregular gallery in the cambium and the female lays eggs along the sides. Attacks usually do not kill trees but may predispose them to attack by other bark beetles. Repeated or extensive attacks by the red turpentine beetle can kill pines. Little can be done to control red turpentine beetles once they are beneath the bark. Good health and vigor in a tree and minimizing fire-related injuries are the best protection against infestation. The feeding activity of the adult beetles and their larval offspring kills a limited amount of living tissue. If enough beetles attack a tree so that feeding areas overlap the tree will die as a consequence of the girdling.

Over the past three years elevated levels of red turpentine beetle activity have been noted in several areas in northeastern California. All cases have been associated with wildfires, prescribed fires or thinning activities. To date, these attacks have not caused elevated levels of pine mortality. In the prescribed fires and wildfires, post-fire mortality has been observed, but was caused by fire-related injuries (primarily cambium kill) as opposed to bark beetle attacks. FPM has been monitoring 50 Jeffrey and ponderosa pine trees on the Lassen NF that were attacked by RTB following a thinning in 1995. The number of attacks on these trees ranged from 2 to 100+ and were found up to 15 ft. above ground line on the bole. To date, two trees have died. Based on this information, observations following other fires, and the moist precipitation pattern over the past three years, I would not anticipate any mortality related to the red turpentine beetle attacks. Additional mortality related to fire injuries can be expected in areas where the fire was hot enough to burn significant portions of the cambium or in areas where the residual tree crown is not sufficient to sustain the tree. At this time, there is no evidence to support including red turpentine beetle attacks alone as a valid criteria for determining future pine mortality.

Western pine beetle, *Dendroctonus brevicomis*

At the time of the field evaluation, I did note a few western pine beetle attacks on live trees and/or trees that would be expected to survive their fire-related injuries. For the reasons mentioned above (adequate precipitation for the past three years and the timing of the fire related to the bark beetle flight) the observation of low levels of bark beetle activity at the time of this field evaluation were not a surprise; however, it is important to continue observations in the area and be aware that an increase in bark beetle activity may occur this spring and summer. Marking trees for removal based on the expectation of *Dendroctonus* sp. beetle attacks during the

following season is not supported by Forest Pest Management. Without current beetle activity, the marking criteria should be based only on fire injuries as described in Wagener's guidelines. These guidelines account for the interaction between fire-related injuries and subsequent bark beetle attacks associated with the amount of cambium and crown injury.

The western pine beetle breeds in the main bole of living ponderosa pine larger than about 8 inches dbh. Normally, it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe, or fire. Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year. Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pitch tubes are formed on the tree trunk around the entry holes. The pitch tubes are red-brown masses of resin and boring dust. Relatively few, widely scattered, white pitch tubes usually indicate that the attacks were not successful and that the tree will survive. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over into nearby trees creating "group kills".

The availability of suitable host material is a key condition influencing western pine beetle outbreaks. In northeastern California, drought stress may be the key condition influencing outbreaks. When healthy trees undergo a sudden and severe moisture stress, populations of western pine beetle are likely to increase. Healthy trees ordinarily produce abundant amounts of resin, which pitch out or eject attacking beetles. When deprived of moisture, stressed trees cannot produce sufficient resin flow to resist attack. Any condition that results in excessive demand for moisture, such as tree crowding, competing vegetation, protracted drought periods, or any condition that reduces that ability of the roots to supply water to the tree, such as mechanical damage, root disease, or soil compaction, can cause moisture stress and increase susceptibility to attack by the western pine beetle.
Trees damaged by wildfires and prescribed fires may be more susceptible to successful attack depending on the timing of the fore in relation to beetle emergence and flight period, bark beetle population levels in the general area prior to the fire, fire intensity, and health and vigor of the trees.

Secondary insects

The presence of wood borer frass on the boles, and galleries under the bark, was noted on several of the fire killed trees. There are a number of species of flatheaded (family Buprestidae) and roundheaded borers (family Cerambycidae) that mine in the sapwood, and in some cases, in the heartwood of injured, and dead and dying trees. Attacks initially occur within the first few years after a fire, but may continue for 4 or 5 years, as long as the wood remains sound. The damage to the sapwood and heartwood from these insects, along with fungal deterioration, can be a factor in determining the limit of practical salvage in an area. At this time, wood borers would not be expected to cause any concerns with the trees that survived the fire unless their extent exceeds about 1/3 of the circumference of the bole on individual trees.

Insects that bore into the sapwood and cause degradation also include the ambrosia or pinhole borers. The defect caused by this beetle consists of small holes surrounded by a dark "ambrosia fungi" stain. Galleries are constructed within the sapwood where the larvae feed on the ambrosia fungus which is introduced by the female beetle as she constructs the galleries. Ambrosia beetles

were present in some of the fire-killed trees as evidenced by piles of fine, white boring dust in the bark crevices.

Wood borers and ambrosia beetles are common in weakened, injured and dying and dead trees following wildfires and are important components in decomposition of the wood. Depending upon management objectives, prompt removal of the dead trees will keep the damage to the wood at a minimum. The presence of wood borers and ambroisa beetles does not always indicate tree mortality. They can commonly be found working in the areas on the bole that have cambium damage and the presence of frass or boring dust associated with them is a valid criteria to use to determine the percentage of the circumference that has cambium damage (refer to Wagener's guidelines).

Fir engraver, *Scolytus ventralis*

Attacks by the fir engraver beetle were not observed during the field evaluation. Fir engraver beetles may attack some of the fire-damaged true firs; however, at this time addtional fir engraver-related mortality beyond those trees that were either killed outright by the fire or those that will die from their fire-related injuries is not expected at this time. Trees need to monitored for the presence of frass and/or boring dust, and new top kill or scattered branch dieback to confirm infestation by the fir engraver beetle. Pitch streamers are not a consistent, valid criteria to use for determining the presence or absence of fir engraver.

The fir engraver attacks red and white fir in California. Fir engraver adults and developing broods kill true firs by mining the cambium, phloem, and outer sapwood of the bole, thereby girdling the tree. Trees greater that 4 inches in diameter are attacked and often killed in a single season. Many trees, weakened through successive attacks, die slowly over a period of years. Others may survive attack as evidenced by old spike-topped fir and trees with individual branch mortality. Although many other species of bark beetles cannot develop successful broods without first killing the tree, the fir engraver beetle is able to attack and establish broods when only a portion of the cambium area has been killed.

Fir engravers bore entrance holes along the main stem. Reddish-brown or white boring dust may be seen along the trunk, in bark crevices, and in spider webs, and is associated with these entrance holes. Some pitch streamers may be indicative of fir engraver attacks; however, true firs are known to stream pitch for various reasons and there is not clear evidence that pitch streamers indicate subsequent tree mortality. Resin canals and pockets in the cortex of the bark are part of the trees defense mechanism. Beetle galleries that contact these structures almost always fail to produce larval galleries as the adults invariably abandon the attack. Pitch tubes that are often formed when bark beetles attack pine are not produced on firs.

Fir engravers bore into any member of the host species on which they land but establish successful galleries only in those which have little or no resistance to attack. Populations of less aggressive beetle species like fir engraver are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality; however, attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a contributing factor. Overstocking and the increased presence of fir on sites that

were once occupied by pine species may also contribute to higher than normal levels of fir engraver-related mortality.

Discussion

Fire damaged trees can be placed into three categories: 1) those killed outright or so severely damaged by the fire that they are dead or will soon die; 2) those that are undamaged or lightly damaged and should survive, and 3) those in between. Based on my observations in the areas we visited, most of the trees are in either category 1 or 2. Trees in the third category present the challenge in marking for salvage and also may provide the opportunity for subsequent attack by bark beetles.

Based on information from other wildfires in California, trees not injured by the fire either within the area of the burn or in the surrounding forest are rarely attacked as a result of the concentration of bark beetle attacks in fire-injured trees. As mentioned previously, a period of moisture stress could be an exception. Concentration of beetles and related losses typically occur within the first two years after the fire so trees around the fire, boundaries and islands of green trees within should be monitored for bark beetle activity through 2001.

Decisions about post-fire harvest and stocking levels affect the biological and economic potential of a stand. Unfortunately, it is often difficult to separate injured trees which are likely to live from those which are likely to die. The guidelines noted above (Wagener, 1961 and Weatherspoon, 1997) are the most appropriate to use for California forest conditions. Trees with moderate damage should be marked for removal when they do not meet the minimum criteria for survival. Damage to the crown and intensity of the fire, which indicates cambium injury, provide an index to mortality. An adequate number of trees within descrete areas of the burn should be sampled to determine the level of cambium damage for a given area. Sampling the cambium for damage is the proper procedure to assess the extent of cambium kill. Bark scorch or crown damage are not accurate indicators of damage to the cambium.

If pines with some green foliage are cut, any slash >6 inches in diameter could be used as breeding material for pine engravers, *Ips* sp. During the warm parts of the year, pine engravers can complete their life cycle in less than 2 months. If populations are allowed to build up and emerge from the slash they can attack standing residual trees and cause either whole tree mortality or top kill. Pine slash can be treated by lopping and bucking the boles and larger stems into the shortest pieces possible (varies depending on diameter but typically about 3 ft.). The material should be scattered so the stems are fully exposed to the sun to facilitate drying. Other methods of slash treatment include chipping, removing from the site or piling and burning. Two practices which should generally be avoided are piling fresh slash without further treatment and/or allowing slash to remain in contact with or near leave trees.

The best way to reduce future bark beetle-related mortality is to maintain the stand at stocking levels that are appropriate for the site, including diverse species composition, ages and size classes. It is recommended that activities such as thinning or underburning be implemented during periods of relatively low tree stress (i.e. during high precipitation years and prior to stands becoming overstocked). This provides the opportunity for trees to recover more quickly from the management activity and doesn't induce additional stresses on the trees. Additional stresses increase the susceptibility of successful bark beetle attack.

I will continuing working with Mike Mateyka on the marking guidelines and will assist you with any further needs you may have. Please feel free to call me at 530-252-6667 if you have more questions or need to request additional assistance in the field.

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